DOCUMENT RESUME

ED 135 609 SE 021 973

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TITLE Admission and Attrition of Women in Graduate School.
PUB DATE Feb 76
NOTE 24p.; Paper presented at the annual meeting of the American Association for the Advancement of Science (Boston, Massachusetts, February 22-23, 1976); Not available in hard copy due to marginal legibility of original document

EDRS PRICE MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS Doctoral Programs; *Females; *Graduate Study; Higher Education; *Science Education; Scientific Manpower; *Scientists; *Sex Discrimination; Speeches

ABSTRACT

Reasons behind the fact that there are fewer women scientists than men scientists are explored in this paper. Data on the number of women Ph.D.'s in each field of science for the years 1966 through 1974 are presented and analyzed. Graduate school admissions policies and the greater attrition rate for women in graduate school compared to men are discussed. Finally, recommendations are made for ways of combating and preventing discrimination in graduate programs. (DT)

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Paper presented at AAAS Session: "Bicentennial Retrospectives and Prospectives: Science Education for Women" (February 23, 1976)

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Admission and Attrition of Women in Graduate School

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All of us in this room are very aware that there are fewer women than men scientists. And we all know that this indicates a lack of opportunity and freedom of choice for women. Furthermore, it means that a human resource of the nation is untapped and underutilized. Others on this panel have addressed early education and socialization and its contribution to this result. I will limit myself in this talk to exploring what effect graduate education has on the final result: more men than women scientists.

Before starting I would like to point out that projections of employment prospects for Ph.D.'s show that there will be a large oversupply by 1985. The first slide shows the projections made by the National Science Foundation and by the Bureau of Labor Statistics [1]. These differ markedly from each other but both paint a dismal picture. However, the picture for scientists and engineers is much better than for graduates in the humanities and social sciences, or education, and there are uncertainties in the models making the predictions. In this talk I stress the need to increase the percentage of women among doctoral recipients because I feel the small current percentages reflect a lack of opportunity for women in a choice of career.

The number of women Ph.D.'s varies greatly with the field of science. And, more of interest, the percentage of women among recipients of the Ph.D. degree varies greatly between disciplines, being lowest

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in physics, and engineering, higher in chemistry, mathematics, economics, political science and highest in the biological sciences, psychology and sociology. While the number of degrees awarded women each year has increased markedly since the 1920's in all fields, the percentage of women among doctoral recipients has not; it shows a decline after the 1920's which as the second slide shows has been reversed in the 1960's [2], [3], [4]. The upper part of the slide plots the average number of doctorates awarded to women per year, and the lower part shows the percentage of women in the doctorates awarded in the life sciences, (including agriculture), social sciences (including psychology), natural sciences (including mathematics and engineering.) This figure is taken from an article by Vera Kistiakowsky, and is compiled from data reported in the Summary Reports of Doctorate Recipients from U.S. Universities of the National Academy of Sciences. The variation between disciplines in both number and percentages is apparent and the curves for percentages show the decrease and then the increase of which I spoke. In the last few years there has been a significant increase in the percentage of women among doctoral recipients, due partly to a decrease in the number of men awarded doctorates, as shown in the next slide (slide 3), [4], [5], and (slide 4), [2], [3], [4].

For most fields of science, graduate departments draw their entering graduate students from among students with bachelors degrees in that discipline. On the next slide (slide 5), I show percentages of women among recipients of bachelors, masters and doctoral degrees for a number of specific fields. The data is from the Office of Education's Earned Degrees Conferred, 1971-72. [6]. The variation between

fields is apparent; physics low; chemistry, mathematics, political science and economics next; the biological sciences, sociology, and psychology the largest in the percentage of women among recipients of doctoral degrees. For all fields, this percentage is considerably lower than the percentage among recipients of bachelors degrees, by a factor ranging between 1.5 and 2.7, except for mathematics for which the factor is 5. Of course, the number of doctorates awarded both men and women is always much less than the number of bachelors degrees awarded. But it should be just as likely for a woman with a bachelors degree in a discipline to get a Ph.D. in that discipline as it is for a man; i.e. the percentage of women among recipients of the doctoral degree should be equal to the percentage of women among recipients of the bachelors degree. (Note that the percentage of women among masters degree recipients is much larger than that of the percentage of doctorates and for many disciplines is about the same as the percentage of bachelors or even larger. I will discuss this point later.) We should compare percentages of doctorates with those of bachelors at an earlier time, say six years earlier. Since the percentage of women among bachelor recipients was smaller in 1965-66 for most of these fields, the gap is slightly smaller than the figures show. In fact, if we use the most recent available data for doctoral degrees; i.e. 1973-74 [5] and compare the percentages of doctoral recipients with the percentage of bachelor recipients in 1968-69 [6], then doctorates are reduced compared to bachelors by a smaller factor in all of these fields, the factor ranging between 1.3 and 2.1 with the factor in mathematics 4

instead of 5. These figures, still greater than 1, show that graduate education presents a bigger barrier to women than to men.

There are several possible reasons for this decrease in the percentage of women among doctoral recipients. 1) Women are less likely to apply to graduate school 2) Women are less likely to be admitted 3) Women are less likely to finish to a Ph.D. once enrolled.

To try to determine which factors are important I present more national statistics in the next slide (slide 6). The first column again gives the percentage of women among bachelor degree recipients in 1971-72 [6]; the second column gives the percentage of women among first-year graduate students; i.e. students who have completed less than one year of graduate school by the fall term of 1972. The third gives the percentage of women among students who are beyond the first year in the fall of 1974. The last column gives the percentage of women among Ph.D.'s granted in 1973-74 [5]. The second and third columns are NSF data [7]. The students were enrolled full-time in doctorate departments, the 3785 departments were the same in 1972 and 1974, and the questionnaires were filled out by chairpersons. We see that in the physical sciences, the biological sciences and in the "hard social sciences"(i.e. physics, chemistry, the biological sciences, economics, political science) the percentage of women enrolled as first-year students in the fall of 1972 is essentially the same as the percentage among recipients of bachelor degrees in 1971-72, so women seem to be applying and being admitted to graduate school in these fields in the same proportions as men. The picture is very different in mathematics,

psychology and sociology where the percentage of women among first-year graduate students is greatly decreased compared to the percentage among bachelor recipients. Women with bachelors degrees in sociology have a greater tendency than men to go into social work rather than graduate school [8]. I believe that the high percentage of women with bachelors degrees in mathematics is due to men with comparable skills majoring in engineering, an option women do not choose.

Comparison of columns two and three indicates that there is higher attrition of women than of men after enrollment in graduate school. Women who are "beyond the first year" in the fall of 1974 entered graduate school in the fall of 1973 or before. The percentage of women among students beyond the first year in the fall of 1974 is smaller than the percentage of women among the first-year graduate students in the fall of 1972. There is also greater attrition of women in the last years of graduate school (compare columns 3 and 4) although, since the doctoral percentages are increasing and since I should use degree data from a later date (not yet available) the attrition in the last years of graduate school is not as large as here indicated. I should mention that the Office of Education also collects statistics on the number of students enrolled at the first year and beyond the first year [9]. Their definition of first-year student differs from that of NSF and data are collected by questionnaires to the institution not to chairpersons. While the number of students in the first year differ from those presented by NSF, the percentage of women are close to NSF's and this greater attrition of women in later years of doctoral study is also borne out.

These national statistics indicate that there is a greater attrition of women after entering graduate school and that while for many fields women are as likely to enter graduate school as men there are some fields where this is not true. I would like to examine admission and attrition in somewhat more detail.

Some universities have tried to determine if there is discrimination against women in admissions by asking if the percentage of women among students admitted is the same as the percentage among students applying. Bickel, Hammel and O'Connell reported in Science, February 7, 1975, on such statistics for the fall 1973 at the University of California Berkeley [10]. They found that if all data on graduate admissions were aggregated, there seemed to be a clear bias against women. But if the data were properly pooled, taking into account the autonomy of departmental decision making, thus correcting for the tendency of women to apply to graduate departments where the acceptance rate is lower for both sexes, there is a small but statistically significant bias in favor of women. Parenthetically, the graduate departments with the higher acceptance rate were those requiring more mathematics and thus having fewer women applicants. This does not address itself to the question of the relative qualification of the women and men applying. Women who are enrolled in graduate school have higher undergraduate QPA's, which indicates that more qualified women are rejected than men [11]. And, of course, statistics showing no bias do not rule out the bias in individual cases. For instance, there are scientific fields which bias against older students, many of whom are women, returning to school after raising families. Married women may be discriminated against, if not in admissions, then for fellowships and teaching assistantships, the arguments being that they don't "need"

it. It is not illegal to request age on application forms, and all universities have such a question. It is illegal to ask marital status on application forms for admission or fellowships (under Title IX). I just collected application forms from eleven Universities, and to my surprise I found that four are still asking marital status and number of dependents, three ask marital status, one says ignore questions on marital status, and three did not ask or made the question optional.

Another question one can ask about admissions is whether women are being admitted into the best graduate schools or are attending graduate schools and receiving Ph.D.'s from lesser quality institutions. McCarthy and Wolfe in Science, September 12, 1975, [12], report on the Ph.D. production at the 46 universities who are members of the Association of American Universities. These universities award 60% of the Ph.D's; they include 89% of all graduate departments rated as "distinguished" or "strong" in the 1969 Roose-Anderson survey. For the fields I have been discussing, the percentage of women among doctoral recipients at these institutions is higher than the average of all Universities except in physics and mathematics where it is slightly smaller (slide 7). No difference was found between the percentages at departments rated "distinguished" or "strong" by Roose-Anderson and those for the whole group of AAU members.

The statistics I presented earlier indicate a greater attrition of women in graduate school. A careful study of attrition of Woodrow Wilson Fellows of 1958-63 confirms this [13],[14]. By 1966, 26% of

the men and 54% of the women in the natural sciences had not obtained doctorates or were no longer enrolled; in the social sciences the percentages were 46% for men and 64% for women.(slide 8) The attrition of even this select group of students is very high and much higher for women than men.

What are the causes for greater attrition once women are in graduate school? Women may enter graduate school with lower aspirations than men; i.e. they intend only to work for a master's degree. The fact that the percentage of women among recipients of the master's degree is much higher than for doctoral recipients indicates women are more likely than men to stop with the master's degree rather than continuing to the Ph.D. Graduate school should change aspirations, so I consider this as attrition. Less financial support for women than men could cause greater attrition. Data collected by NSF [7] in 1972, 1973, and 1974 shows that a higher proportion of women full-time graduate students in doctorate granting departments are self-supporting in the life sciences, psychology, social sciences, and mathematics than the men in these disciplines. (slide 9) The survey of doctorate recipients made by the National Research Council [5] shows no difference in self-support for women and men who attained the doctorate in 1974. The NSF data [7] shows somewhat greater institutional support (meaning teaching assistantships) for women in the physical sciences and the mathematical sciences compared to U.S. Government support (graduate research assistantships, fellowships). There is thus evidence that there is less support for women than men.

Another cause for greater attrition of women than men might be lack of encouragement by faculty of women students. Closely connected to this is the possibility that women students lack confidence and motivation. The ACE/Carnegie Commission Survey of 1969 asked two questions designed

to throw light on these questions [13], [11]. (This survey was designed very carefully for correct sampling; 33,000 graduate students and 60,000 faculty members responded to the survey). Two of the questions asked were: Do you agree or disagree with the statement "females are not as dedicated as males" and do you agree or disagree with the statement "professors in my department don't really take female graduate students seriously". To the second question, a range of 15-50% of the graduate students in the disciplines I have been discussing agreed with the statement (slide 10). To the first question 20-40% of the male faculty agreed with the statement but only 4-24% of the women. I think that these two questions pinpoint very well the attitudes which cause so much trouble for women in graduate school. And they certainly must be a cause for the greater attrition of women. What is so unfortunate is that they feed on each other. If a professor does not treat a female graduate student seriously, this can have the effect of making her less serious or less dedicated. And then this behavior just reinforces the professor's attitude.

Marital and family responsibilities can clearly make it more difficult for a woman than a man to stay in graduate school. A higher percentage of women than men doctoral recipients are single. Women with children find it difficult to find inexpensive child care. Women are more likely to feel they must quit graduate school to follow husbands to another city. Women who wish to return to school after an absence to raise children find the adjustment difficult; they find financial support hard to find. I think attrition of this particular group of students is low.

The women's movement has clearly had an effect on increasing the number of women doctorates. Women have more confidence in their abilities; they have a clearer set of career goals; their concepts of the opportunities which are open to them have broadened. The changing of attitudes is a long process and discrimination is very subtle. I recommend the formation of caucuses of women graduate students as a more effective means to combat discrimination than grievance procedures which are so hard on an individual student. The women graduate students in two of our departments have formed women's causes, and these can have a positive effect on preventing discrimination or alleged discrimination in graduate departments and in providing psychological support for women involved. The most effective means in the long run is the presence of women faculty in science departments which helps prevent discrimination in individual cases and produces an atmosphere of equality between men and women which is of psychological benefit to all graduate students and will decrease the attrition of women graduate students.

1. Gina Bari Kolata, Science 191, 363 (1976)

2. Vera Kistiakowsky, "Women Doctoral Scientist in the United States (1973)."

3. "Doctorates Awarded from 1920 to 1971 by Subfield of Doctorate, Sex and Decade," National Academy of Sciences (1973).

4. "Summary Report 1972. Doctorate Recipients from U.S. Universities," National Academy of Sciences (1972).

5. "Summary Report 1974. Doctorate Recipients from U.S. Universities," National Academy of Sciences (1974).

6. "Earned Degrees Conferred, 1971-72," U.S. Office of Education. (An annual report).

7. "Graduate Science Education Student Support and Postdoctorals Fall 1974. Detailed Statistical Tables, Appendix III". National Science Foundation.

8. Joseph Zelan in Teachers and Students, Martin Trow (editor) McGraw-Hill Book Company, New York (1975).

9. "Students Enrolled for Advanced Degrees, Fall 1972," Office of Education.

10. P.J. Bickel, E.A. Hammel, and J.W. O'Connell, Science 187, 398 (1975).

11. Saul D. Feldman, Escape from the Doll's House, Women in Graduate and Professional School Education, McGraw-Hill Book Company, New York (1974).

12. J.L. McCarthy and D. Wolfe, Science 189, 856 (1975).

13. "Opportunities for Women in Higher Education," The Carnegie Commission on Higher Education, McGraw-Hill Book Co., New York (1973).

14. M. Patterson and L. Sells in Academic Women on the Move, Russell Sage Foundation, New York (1973).

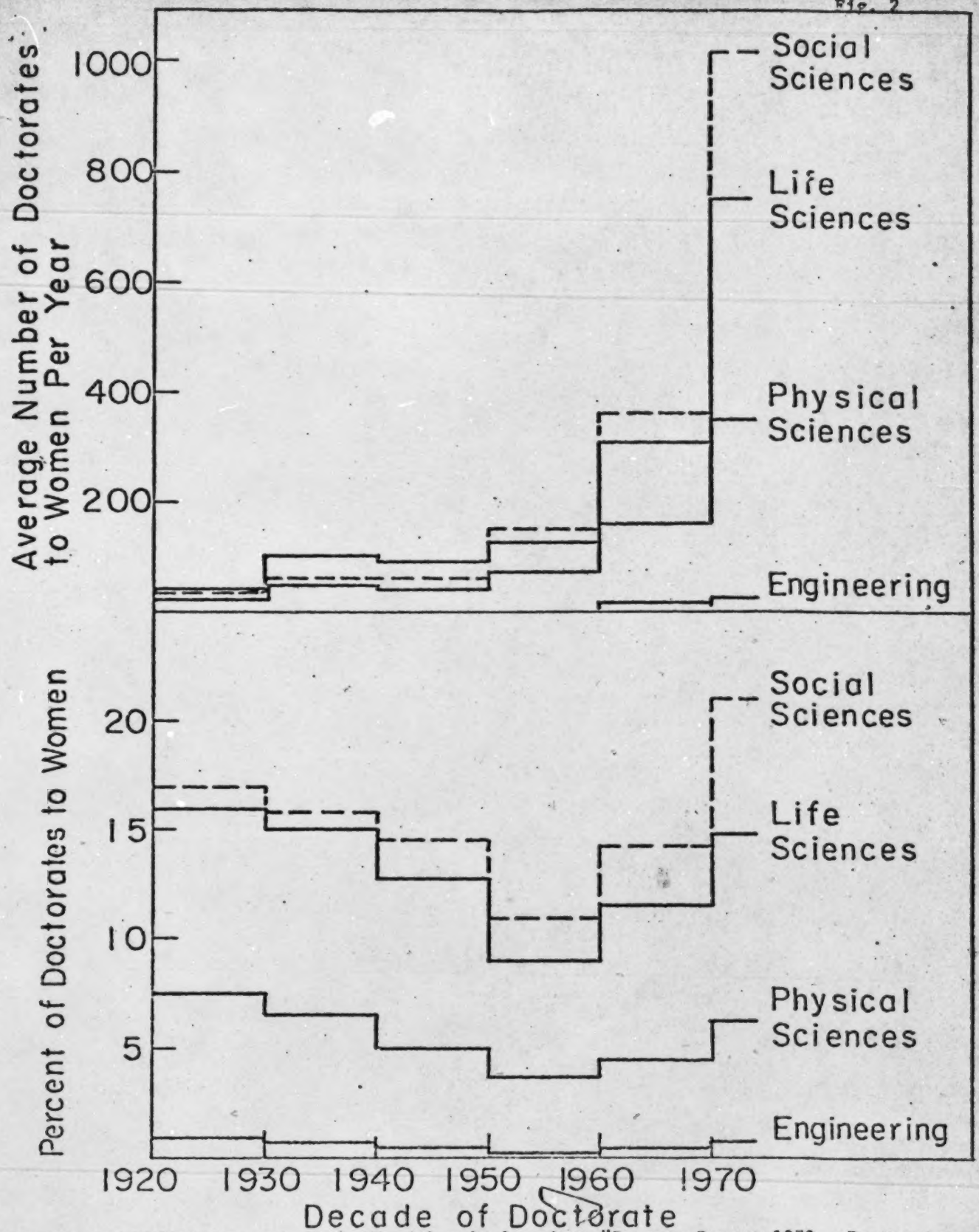
Comparisons of the National Science Foundation and the Bureau of Labor Statistics of Employment Prospects for Ph.D's in 1985

	Number of Ph.D.'s			
	Supply	Demand	Surplus	Percent surplus
National Science Foundation				
Physical sciences	85,200	76,000	9,200	10.8
Engineering	63,300	45,000	18,300	28.9
Mathematics	21,600	16,000	5,600	25.9
Life sciences	92,100	85,000	7,100	7.7
Social sciences	112,700	71,000	41,700	37.0
Bureau of Labor Statistics				
Physical sciences	118,700	91,700	27,000	22.7
Engineering	80,100	59,100	21,000	26.2
Mathematics	31,400	19,800	11,600	36.9
Life sciences	137,700	73,100	64,600	46.9
Social sciences	153,700	87,100	66,600	43.3

Reference: Science 191, 363 (1976)

Slide 1

Fig. 2



Reference: Unpublished paper, Vera Kistiakowsky based on "Summary Report 1972. Doctorate Recipients from U.S. Universities" National Academy of Sciences and Doctorates Awarded from 1920 to 1971 by Subfield of Doctorate, Sex and Decade," National Academy of Sciences

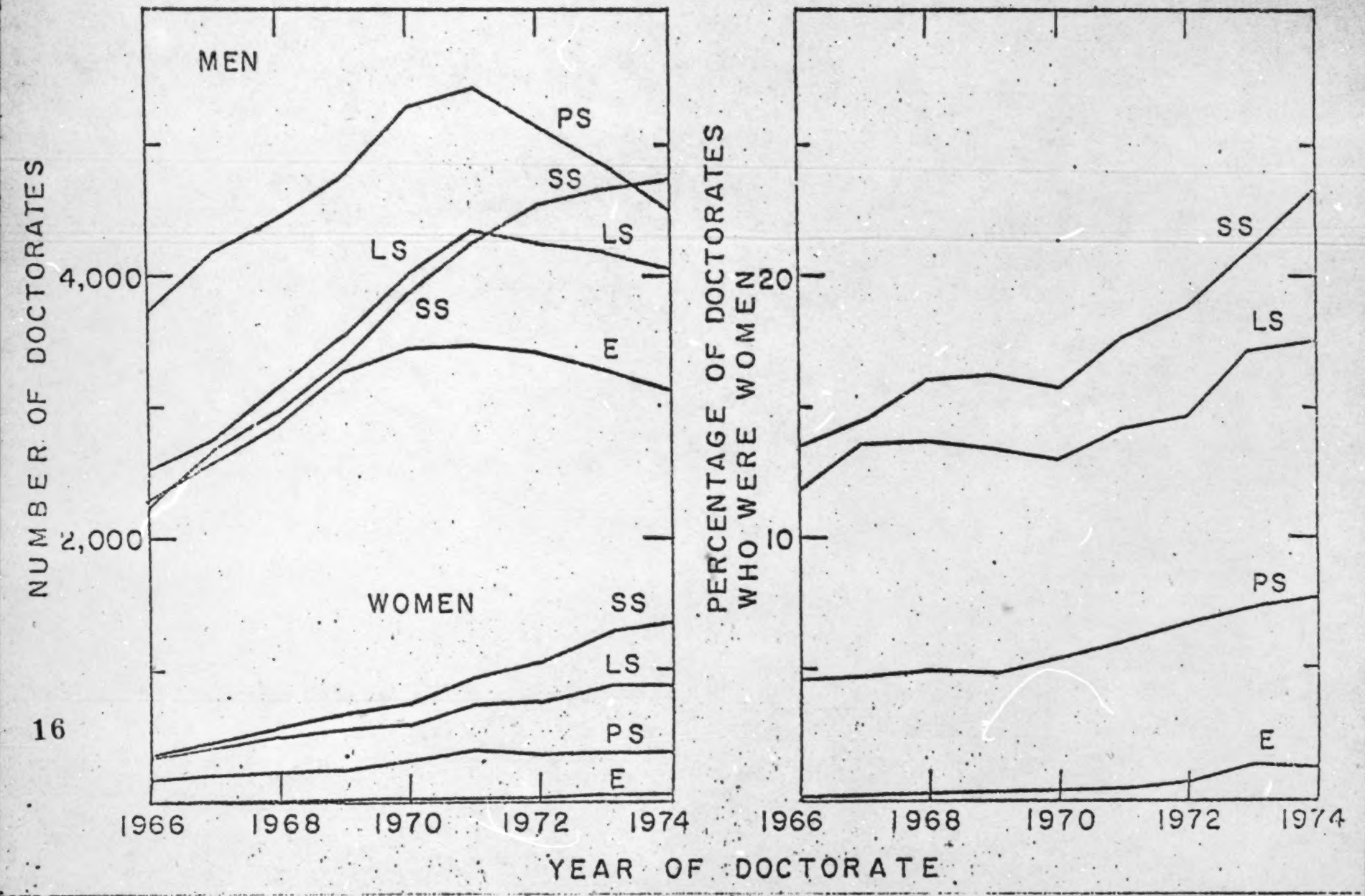
Slide 2

Percentage of Women Among the Recipients of Doctoral Degrees

	1971-72	1973-74
Physics	2.8	4.3
Chemistry	10.0	9.7
Mathematics	7.5	9.6
Biological Sciences	18.5	21.5
Psychology	26.7	30.6
Economics	6.6	8.8
Political Science	10.5	14.8
Sociology	21.6	28.5

Reference: "Summary Report 1974 Doctorate Recipients from U.S. Universities", National Academy of Sciences and same report for 1972.

Slide 3



16

Reference: Unpublished paper, Vera Kistiakowsky and ""Summary Report 1974. Doctorate Recipients from U.S. Universities", National Academy of Sciences

Slide 4

17

Percentage of Women Among all Recipients of Bachelors, Masters and Doctoral Degrees in 1971-72

	% Bachelors	% Masters	% Doctoral
Physics	7.0	7.7	3.1
Chemistry	19.8	22.1	9.7
Mathematics	39.1	29.8	7.9
Biological Science	29.6	33.1	17.0
Psychology	46.4	38.4	24.8
Economics	11.8	12.8	7.6
Political Science	18.9	20.5	10.6
Sociology	57.0	38.8	21.4

Reference: U.S. Office of Education: "Earned Degrees Conferred, 1971-72."

Slide 5

Percentage of Women Among Students at Various Educational Levels

	Bachelors (1971-72)	First Yr. Grad.* (Fall 1972)	Beyond First Yr.* (Fall 1974)	Doctoral (1973-74)
Physics	7.0	8.4	5.7	4.3
Chemistry	19.8	18.3	14.5	9.7
Mathematics	39.1	21.7	16.2	9.6
Biological Sciences	29.6	29.2	26.3	21.5
Psychology	46.4	37.7	37.8	30.6
Economics	11.8	14.7	13.7	8.6
Political Science	18.9	21.4	19.9	14.8
Sociology	57.0	39.5	36.1	28.5

* Full-time graduate students enrolled in doctorate departments (matched departments).

References: "Earned Degrees Conferred, 1971-72, U.S. Office of Education
"Graduate Science Education Student Support and Postdoctorals Fall 1974. Detailed Statistical Tables, Appendix III". National Science Foundation
"Summary Report 1974 Doctorate Recipients from U.S. Universities", National Academy of Sciences

Slide 6

Percentage of Women Among the Recipients of Doctoral Degrees

	AAU Universities (1972-75)	All Universities (1973-74)
Physics	3.8	4.3
Chemistry	12.7	9.7
Mathematics	9.1	9.6
Biological Sciences	22.1	21.5
Psychology	34.7	30.6
Economics	10.4	8.8
Political Science	18.3	14.8
Sociology	31.4	28.5

References: Science 189, 856(1975)
"Summary Report 1974. Doctorate Recipients from U.S. Universities", National Academy of Sciences (1974)

Slide 7

Percentage of Woodrow Wilson Fellows Who Dropped Out

	Men	Women
Humanities	52	66
Social Sciences	46	64
Natural Sciences	26	54
Total	44	64

Source: Sells (1973)

Reference: "Opportunities for Women in Higher Education", The Carnegie Commission on Higher Education

Slide 8

Percentage of Men and Women Students with Each Source of Support*

	Phys. Sci.		Math. Sci.		Life Sci		Psych		Soc. Sci	
	M	W	M	W	M	W	M	W	M	W
U.S. Government	32	24	11	7	31	32	24	25	14	17
Institutional	50	58	63	66	38	36	37	36	40	34
Self-support	11	11	20	21	22	27	32	34	37	44
Other	7	7	6	6	9	5	7	5	9	5

*Full-time graduate students in doctoral departments, Fall 1974 (NSF)

Reference: "Graduate Science Education Student Support and Postdoctorals, Fall, 1974." Detailed Statistical Tables, Appendix III, NSF

Slide 9

Attitudes toward Women Graduate Students

	% Faculty who agree with (1)		% Students who agree with (2)	
	M	W	M	W
Physics	25.5	3.7	23.5	16.7
Chemistry	39.9	19.8	25.4	32.1
Mathematics	29.3	16.4	15.0	16.3
Biological Sci.	~32	~20	~30	~30
Psychology	31.1	8.1	20.1	23.8
Economics	23.0	14.5	24.0	32.3
Political Sci.	20.1	10.2	20.0	50.1
Sociology	25.0	3.6	21.8	50.5

(1) Females are not as dedicated as males

(2) Faculty does not take female students seriously

Source: "Escape from the Doll's House, Women in Graduate and Professional School Education" by Saul D. Feldman

Slide 10